

What is claimed is:

1. Use, as a catalyst for oxidation reactions using molecular oxygen and/or air, of at least one metal complex compound of formula (1)



wherein

Me is manganese, titanium, iron, cobalt, nickel or copper,

X is a coordinating or bridging radical,

n and m are each independently of the other an integer having a value of from 1 to 8,

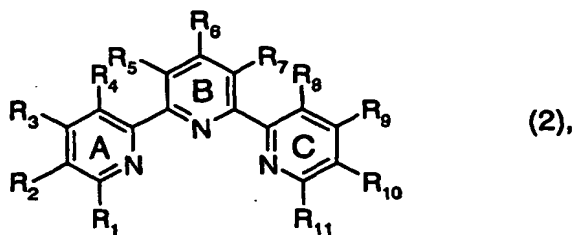
p is an integer having a value of from 0 to 32,

z is the charge of the metal complex,

Y is a counter-ion,

q = z/(charge of Y), and

L is a ligand of formula (2)



wherein

R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, R<sub>9</sub>, R<sub>10</sub> and R<sub>11</sub> are each independently of the others hydrogen;

unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl; cyano; halogen; nitro; -COOR<sub>12</sub> or -SO<sub>3</sub>R<sub>12</sub>

wherein R<sub>12</sub> is in each case hydrogen, a cation or unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or

aryl; -SR<sub>13</sub>, -SO<sub>2</sub>R<sub>13</sub> or -OR<sub>13</sub> wherein R<sub>13</sub> is in each case hydrogen or unsubstituted or

substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl; -NR<sub>14</sub>R<sub>15</sub>; -(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>; -N<sup>⊕</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>;

-(C<sub>1</sub>-C<sub>6</sub>alkylene)-N<sup>⊕</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>; -N(R<sub>13</sub>)-(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>;

-N[(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>]<sub>2</sub>; -N(R<sub>13</sub>)-(C<sub>1</sub>-C<sub>6</sub>alkylene)-N<sup>⊕</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>;

-N[(C<sub>1</sub>-C<sub>6</sub>alkylene)-N<sup>⊕</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>]<sub>2</sub>; -N(R<sub>13</sub>)-N-R<sub>14</sub>R<sub>15</sub> or -N(R<sub>13</sub>)-N<sup>⊕</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub> wherein R<sub>13</sub> is

as defined above and R<sub>14</sub>, R<sub>15</sub> and R<sub>16</sub> are each independently of the other(s) hydrogen or

unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl, or R<sub>14</sub> and R<sub>15</sub>, together with the nitrogen atom linking them, form an unsubstituted or substituted 5-, 6- or 7-membered ring which may contain further hetero atoms.

2. Use according to claim 1, wherein Me is manganese, which is in oxidation state II, III, IV or V.

3. Use according to either claim 1 or claim 2, wherein X is CH<sub>3</sub>CN, H<sub>2</sub>O, F<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, HOO<sup>-</sup>, O<sub>2</sub><sup>2-</sup>, O<sup>2-</sup>, R<sub>17</sub>COO<sup>-</sup>, R<sub>17</sub>O<sup>-</sup>, LMeO<sup>-</sup> or LMeOO<sup>-</sup>, wherein R<sub>17</sub> is hydrogen or unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl, and L and Me are as defined in claim 1.

4. Use according to any one of claims 1 to 3, wherein Y is R<sub>17</sub>COO<sup>-</sup>, ClO<sub>4</sub><sup>-</sup>, BF<sub>4</sub><sup>-</sup>, PF<sub>6</sub><sup>-</sup>, R<sub>17</sub>SO<sub>3</sub><sup>-</sup>, R<sub>17</sub>SO<sub>4</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, F<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup> or I<sup>-</sup>, wherein R<sub>17</sub> is hydrogen or unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl.

5. Use according to any one of claims 1 to 4, wherein n is an integer having a value of from 1 to 4, especially 1 or 2.

6. Use according to any one of claims 1 to 5, wherein m is an integer having a value of 1 or 2, especially 1.

7. Use according to any one of claims 1 to 6, wherein p is an integer having a value of from 0 to 4, especially 2.

8. Use according to any one of claims 1 to 7, wherein z is an integer having a value of from 8- to 8+.

9. Use according to any one of claims 1 to 8, wherein aryl is phenyl or naphthyl each unsubstituted or substituted by C<sub>1</sub>-C<sub>4</sub>alkyl, C<sub>1</sub>-C<sub>4</sub>alkoxy, halogen, cyano, nitro, carboxy, sulfo, hydroxy, amino, N-mono- or N,N-di-C<sub>1</sub>-C<sub>4</sub>alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety, N-phenylamino, N-naphthylamino, phenyl, phenoxy or by naphthylloxy.

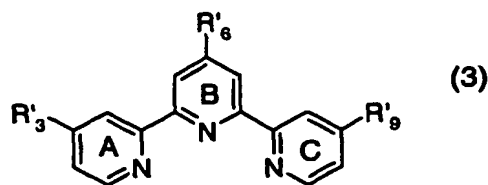
10. Use according to any one of claims 1 to 9, wherein

the 5-, 6- or 7- membered ring formed by  $R_{14}$  and  $R_{15}$  together with the nitrogen atom linking them is an unsubstituted or  $C_1$ - $C_4$ alkyl-substituted pyrrolidine, piperidine, piperazine, morpholine or azepane ring.

11. Use according to any one of claims 1 to 10, wherein

$R_6$  is preferably  $C_1$ - $C_{12}$ alkyl; phenyl unsubstituted or substituted by  $C_1$ - $C_4$ alkyl,  $C_1$ - $C_4$ alkoxy, halogen, cyano, nitro, carboxy, sulfo, hydroxy, amino, N-mono- or N,N-di- $C_1$ - $C_4$ alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety, N-phenylamino, N-naphthylamino, phenyl, phenoxy or by naphthyloxy; cyano; halogen; nitro;  $-COOR_{12}$  or  $-SO_3R_{12}$  wherein  $R_{12}$  is in each case hydrogen, a cation,  $C_1$ - $C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above;  $-SR_{13}$ ,  $-SO_2R_{13}$  or  $-OR_{13}$  wherein  $R_{13}$  is in each case hydrogen,  $C_1$ - $C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above;  $-N(R_{13})-NR_{14}R_{15}$  wherein  $R_{13}$  is as defined above and  $R_{14}$  and  $R_{15}$  are each independently of the other hydrogen, unsubstituted or hydroxy-substituted  $C_1$ - $C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above, or  $R_{14}$  and  $R_{15}$ , together with the nitrogen atom linking them, form an unsubstituted or  $C_1$ - $C_4$ alkyl-substituted pyrrolidine, piperidine, piperazine, morpholine or azepane ring;  $-NR_{14}R_{15}$  or  $-N^+R_{14}R_{15}R_{16}$  wherein  $R_{14}$ ,  $R_{15}$  and  $R_{16}$  are each independently of the other(s) hydrogen, unsubstituted or hydroxy-substituted  $C_1$ - $C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above, or  $R_{14}$  and  $R_{15}$ , together with the nitrogen atom linking them, form an unsubstituted or  $C_1$ - $C_4$ alkyl-substituted pyrrolidine, piperidine, piperazine, morpholine or azepane ring; and  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$ ,  $R_7$ ,  $R_8$ ,  $R_9$ ,  $R_{10}$  and  $R_{11}$  are as defined above or are hydrogen.

12. Use according to claim 11, wherein the ligand L is a compound of formula (3)



wherein

$R'_3$ ,  $R'_6$  and  $R'_9$  have the meanings given for  $R_6$  in claim 11.

13. Use according to claim 12, wherein

$R'_3$ ,  $R'_6$  and  $R'_9$  are each independently of the others  $C_1$ - $C_4$ alkoxy; hydroxy; phenyl unsubstituted or substituted by  $C_1$ - $C_4$ alkyl,  $C_1$ - $C_4$ alkoxy, phenyl or by hydroxy; hydrazine;

amino; N-mono- or N,N-di-C<sub>1</sub>-C<sub>4</sub>alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety; or an unsubstituted or C<sub>1</sub>-C<sub>4</sub>alkyl-substituted pyrrolidine, piperidine, piperazine, morpholine or azepane ring.

14. Use according to claim 13, wherein

R<sub>6</sub> is hydroxy.

15. Use according to any one of claims 1 to 10, wherein there is used at least one metal complex compound of formula (1')



wherein

Me is manganese, titanium, iron, cobalt, nickel or copper,

X is a coordinating or bridging radical,

n and m are each independently of the other an integer having a value of from 1 to 8,

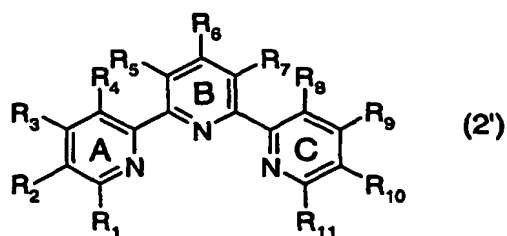
p is an integer having a value of from 0 to 32,

z is the charge of the metal complex,

Y is a counter-ion,

q = z/(charge of Y), and

L' is a ligand of formula (2')



wherein

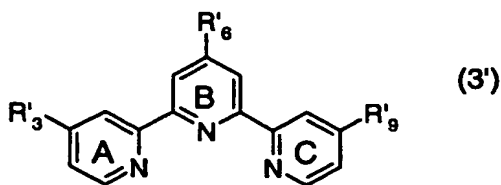
R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, R<sub>9</sub>, R<sub>10</sub> and R<sub>11</sub> are each independently of the others hydrogen; unsubstituted or substituted C<sub>1</sub>-C<sub>16</sub>alkyl or aryl; cyano; halogen; nitro; -COOR<sub>12</sub> or -SO<sub>3</sub>R<sub>12</sub> wherein R<sub>12</sub> is in each case hydrogen, a cation or unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl; -SR<sub>13</sub>, -SO<sub>2</sub>R<sub>13</sub> or -OR<sub>13</sub> wherein R<sub>13</sub> is in each case hydrogen or unsubstituted or substituted C<sub>1</sub>-C<sub>18</sub>alkyl or aryl; -NR<sub>14</sub>R<sub>15</sub>; -(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>; -N<sup>+</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>; -(C<sub>1</sub>-C<sub>6</sub>alkylene)-N<sup>+</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>; -N(R<sub>13</sub>)-(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>; -N[(C<sub>1</sub>-C<sub>6</sub>alkylene)-NR<sub>14</sub>R<sub>15</sub>]<sub>2</sub>; -N(R<sub>13</sub>)-(C<sub>1</sub>-C<sub>6</sub>alkylene)-N<sup>+</sup>R<sub>14</sub>R<sub>15</sub>R<sub>16</sub>;

$-N[(C_1-C_6\text{alkylene})-N^{\oplus}R_{14}R_{15}R_{16}]_2$ ;  $-N(R_{13})-N-R_{14}R_{15}$  or  $-N(R_{13})-N^{\oplus}R_{14}R_{15}R_{16}$ , wherein  $R_{13}$  is as defined above and  $R_{14}$ ,  $R_{15}$  and  $R_{16}$  are each independently of the other(s) hydrogen or unsubstituted or substituted  $C_1-C_{18}$ alkyl or aryl, or  $R_{14}$  and  $R_{15}$ , together with the nitrogen atom linking them, form an unsubstituted or substituted 5-, 6- or 7-membered ring which may contain further hetero atoms, with the proviso that at least one of the substituents  $R_1$  to  $R_{11}$  is a quaternised nitrogen atom that is not bonded directly to one of the three pyridine rings A, B or C.

**16.** Use according to claim 15, wherein

$R_6$  is  $C_{12}$ alkyl; phenyl unsubstituted or substituted by  $C_1-C_4$ alkyl,  $C_1-C_4$ alkoxy, halogen, cyano, nitro, carboxy, sulfo, hydroxy, amino, N-mono- or N,N-di- $C_1-C_4$ alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety, N-phenylamino, N-naphthylamino, phenyl, phenoxy or by naphthyloxy; cyano; halogen; nitro;  $-COOR_{12}$  or  $-SO_3R_{12}$  wherein  $R_{12}$  is in each case hydrogen, a cation,  $C_1-C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above;  $-SR_{13}$ ,  $-SO_2R_{13}$  or  $-OR_{13}$  wherein  $R_{13}$  is in each case hydrogen,  $C_1-C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above;  $-NR_{14}R_{15}$ ;  $-(C_1-C_6\text{alkylene})-NR_{14}R_{15}$ ;  $-N^{\oplus}R_{14}R_{15}R_{16}$ ;  $-(C_1-C_6\text{alkylene})-N^{\oplus}R_{14}R_{15}R_{16}$ ;  $-N(R_{13})-(C_1-C_6\text{alkylene})-NR_{14}R_{15}$ ;  $-N(R_{13})-(C_1-C_6\text{alkylene})-N^{\oplus}R_{14}R_{15}R_{16}$ ;  $-N(R_{13})-N-R_{14}R_{15}$  or  $-N(R_{13})-N^{\oplus}R_{14}R_{15}R_{16}$ , wherein  $R_{13}$  may have any one of the above meanings and  $R_{14}$ ,  $R_{15}$  and  $R_{16}$  are each independently of the other(s) hydrogen, unsubstituted or hydroxy-substituted  $C_1-C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above, or  $R_{14}$  and  $R_{15}$ , together with the nitrogen atom linking them, form a pyrrolidine, piperidine, piperazine, morpholine or azepane ring which is unsubstituted or substituted by at least one unsubstituted  $C_1-C_4$ alkyl and/or substituted  $C_1-C_4$ alkyl, wherein the nitrogen atom may be quaternised, and  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$ ,  $R_7$ ,  $R_8$ ,  $R_9$ ,  $R_{10}$  and  $R_{11}$  may be as defined in claim 1 or are hydrogen.

**17.** Use according to either claim 15 or claim 16, wherein the ligand  $L'$  is a compound of formula (3')

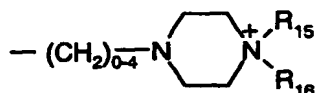


wherein

$R'_3$ ,  $R'_8$  and  $R'_9$  have the meanings given for  $R_8$  in claim 15 or claim 16, but  $R'_3$  and  $R'_9$  may additionally be hydrogen.

**18.** Use according to claim 17, wherein

$R'_3$ ,  $R'_8$  and  $R'_9$  are each independently of the others phenyl unsubstituted or substituted by  $C_1$ - $C_4$ alkyl,  $C_1$ - $C_4$ alkoxy, halogen, phenyl or by hydroxy; cyano; nitro;  $-COOR_{12}$  or  $-SO_3R_{12}$  wherein  $R_{12}$  is in each case hydrogen, a cation,  $C_1$ - $C_4$ alkyl or phenyl;  $-SR_{13}$ ,  $-SO_2R_{13}$  or  $-OR_{13}$  wherein  $R_{13}$  is in each case hydrogen,  $C_1$ - $C_4$ alkyl or phenyl;  $-N(CH_3)-NH_2$  or  $-NH-NH_2$ ; amino; N-mono- or N,N-di- $C_1$ - $C_4$ alkylamino unsubstituted or substituted by hydroxy in the alkyl moiety, wherein the nitrogen atoms, especially the nitrogen atoms not bonded to one of the three pyridine rings A, B or C, may be quaternised; N-mono- or N,N-di- $C_1$ - $C_4$ alkyl- $N^+R_{14}R_{15}R_{16}$  unsubstituted or substituted by hydroxy in the alkyl moiety, wherein  $R_{14}$ ,  $R_{15}$  and  $R_{16}$  are each independently of the others hydrogen, unsubstituted or hydroxy-substituted  $C_1$ - $C_{12}$ alkyl, unsubstituted phenyl or phenyl substituted as indicated above, or  $R_{14}$  and  $R_{15}$ , together with the nitrogen atom linking them, form a pyrrolidine, piperidine, piperazine, morpholine or azepane ring which is unsubstituted or substituted by at least one  $C_1$ - $C_4$ alkyl or by at least one unsubstituted  $C_1$ - $C_4$ alkyl and/or substituted  $C_1$ - $C_4$ alkyl, wherein the nitrogen atom may be quaternised; N-mono- or N,N-di- $C_1$ - $C_4$ alkyl- $NR_{14}R_{15}$  unsubstituted or substituted by hydroxy in the alkyl moiety, wherein  $R_{14}$  and  $R_{15}$  may be as defined above; or a radical

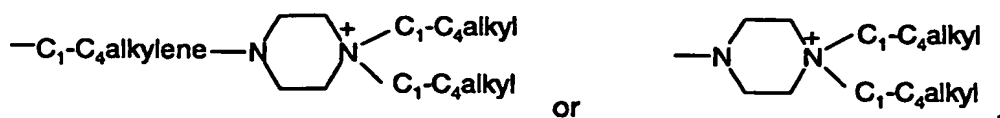


wherein  $R_{15}$  and  $R_{16}$  have the meanings given above, preferably  $C_1$ - $C_4$ alkyl, and the ring is unsubstituted or substituted, wherein  $R'_3$  and  $R'_9$  likewise may additionally be hydrogen.

**19.** Use according to either claim 17 or claim 18, wherein

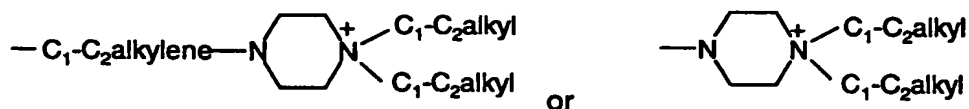
$R_8$  is hydroxy.

**20.** Use according to any one of claims 15 to 19, wherein at least one of the substituents  $R_1$  to  $R_{11}$ , preferably one of the substituents  $R_3$ ,  $R'_3$ ,  $R_6$ ,  $R'_6$ ,  $R_9$  and/or  $R'_9$ , is one of the radicals



wherein the unbranched or branched alkylene group may be unsubstituted or substituted and wherein the alkyl groups, which are unbranched or branched independently of one another, may be unsubstituted or each independently of the others substituted and wherein the piperazine ring may be unsubstituted or substituted.

21. Use according to any one of claims 15 to 20 wherein at least one of the substituents  $R_1$  to  $R_{11}$ , preferably one of the substituents  $R_3$ ,  $R'_3$ ,  $R_6$ ,  $R'_6$ ,  $R_9$  and/or  $R'_9$ , is one of the radicals



wherein the unbranched or branched alkylene group may be unsubstituted or substituted and wherein the alkyl groups, each independently of the others, may be unsubstituted or substituted and wherein the piperazine ring may be unsubstituted or substituted.

22. Use according to any one of claims 1 to 21 for the bleaching of stains or of soiling on textile material, or for the prevention of redeposition of migrating dyes in the context of a hydrogen peroxide-free washing process, or for the cleaning of hard surfaces.

23. Use according to any one of claims 1 to 21, wherein the metal complex compounds of formula (1) and/or (1') are used as catalysts for reactions using molecular oxygen and/or air for bleaching in the context of paper making.

24. Use according to any one of claims 1 to 21, wherein the metal complex compounds of formula (1) and/or (1') are used in selective oxidation reactions in the context of organic synthesis.

25. Use according to any one of claims 1 to 21, wherein the metal complex compounds of formula (1) and/or (1') are used in detergent, cleaning, disinfecting or bleaching compositions.

**26.** Use according to claim 25, wherein the metal complex compounds of formula (1) and/or (1') are formed *in situ* in the detergent, cleaning, disinfecting or bleaching composition.

**27.** A detergent, cleaning, disinfecting or bleaching composition containing

- I) from 0 to 50% by weight A) of at least one anionic surfactant and/or B) one non-ionic surfactant,
- II) from 0 to 70% by weight C) of at least one builder substance,
- III) D) at least one metal complex compound of formula (1) and/or (1') as defined in any one of claims 1 to 26 in an amount that, in the liquor, gives a concentration of from 0.5 to 100 mg/litre of liquor, preferably from 1 to 50 mg/litre of liquor, when from 0.5 to 20 g/litre of the detergent, cleaning, disinfecting or bleaching composition are added to the liquor, and
- IV) water ad 100% by weight,

wherein the percentages are in each case percentages by weight, based on the total weight of the composition.

**28.** A solid formulation containing

- a) from 1 to 99% by weight of at least one metal complex compound as defined in any one of claims 1 to 21,
- b) from 1 to 99% by weight of at least one binder,
- c) from 0 to 20% by weight of at least one encapsulating material,
- d) from 0 to 20% by weight of at least one further additive and also
- e) from 0 to 20% by weight water.

**29.** A solid formulation according to claim 28, which is in the form of granules.